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Furuya

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(54) **SPIN TREATMENT APPARATUS**

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Aug. 8, 2014 (JP) 2014-162096

(51) **Int. Cl.**

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G03F 7/16	(2006.01)
G03F 7/30	(2006.01)
G03F 7/42	(2006.01)
H01L 21/687	(2006.01)

(52) **U.S. Cl.**

CPC ***G03F 7/162*** (2013.01); ***G03F 7/3021*** (2013.01); ***G03F 7/42*** (2013.01); ***H01L 21/68728*** (2013.01)

(58) **Field of Classification Search**

USPC 118/500, 52, 612, 56, 319, 320
See application file for complete search history.

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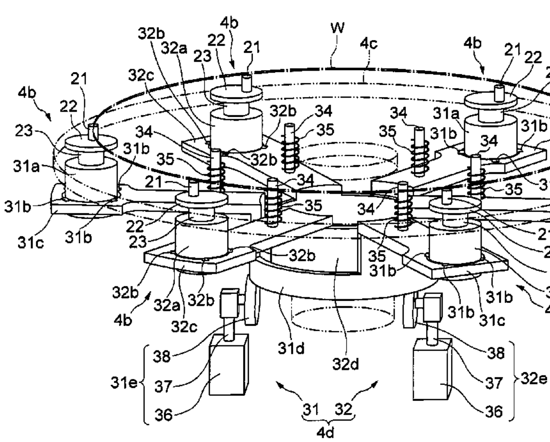
(57) **ABSTRACT**

A spin treatment apparatus according to an embodiment performs a treatment while rotating a substrate and includes: at least three clamp pins configured to contact an outer peripheral surface of the substrate and clamp the substrate; rotatable pin rotators provided for the respective clamp pins and each configured to retain the corresponding clamp pin at a position offset from a rotation axis of the pin rotator parallel with a rotation axis of the substrate; magnet gears provided for the respective pin rotators around outer peripheral surfaces thereof and each having a magnetic-pole part formed spirally about the rotation axis of the pin rotator; rotation magnets provided for the respective magnet gears and positioned to attract and be attracted by the magnetic-pole part of the corresponding magnet gear; and a movement mechanism configured to move the rotation magnets along the rotation axes of the pin rotators.

9 Claims, 8 Drawing Sheets



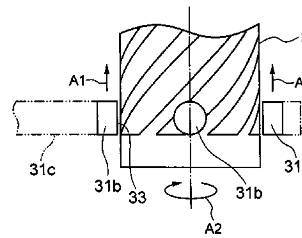
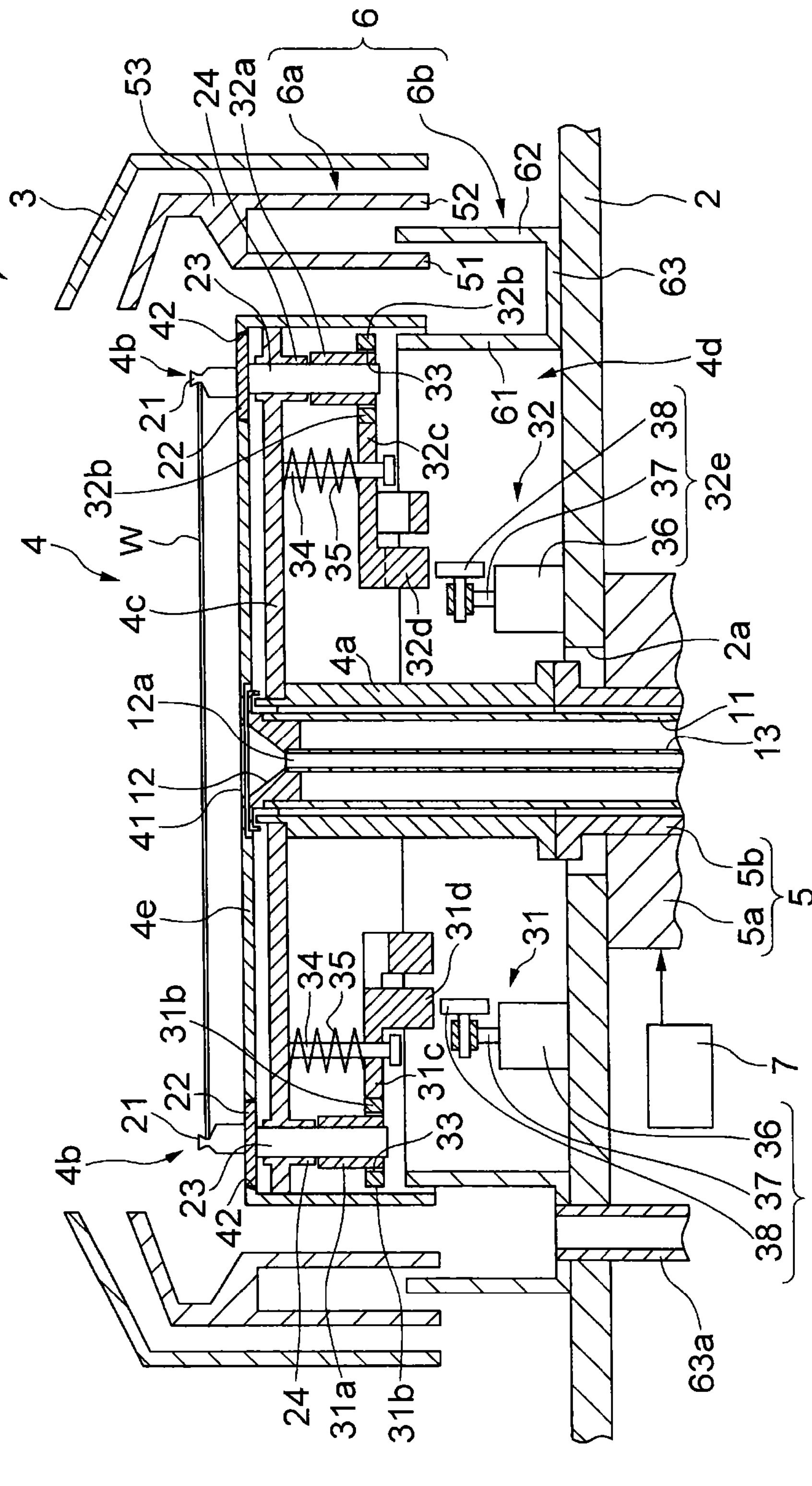


FIG. 1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32c
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63
63a
W

FIG.2

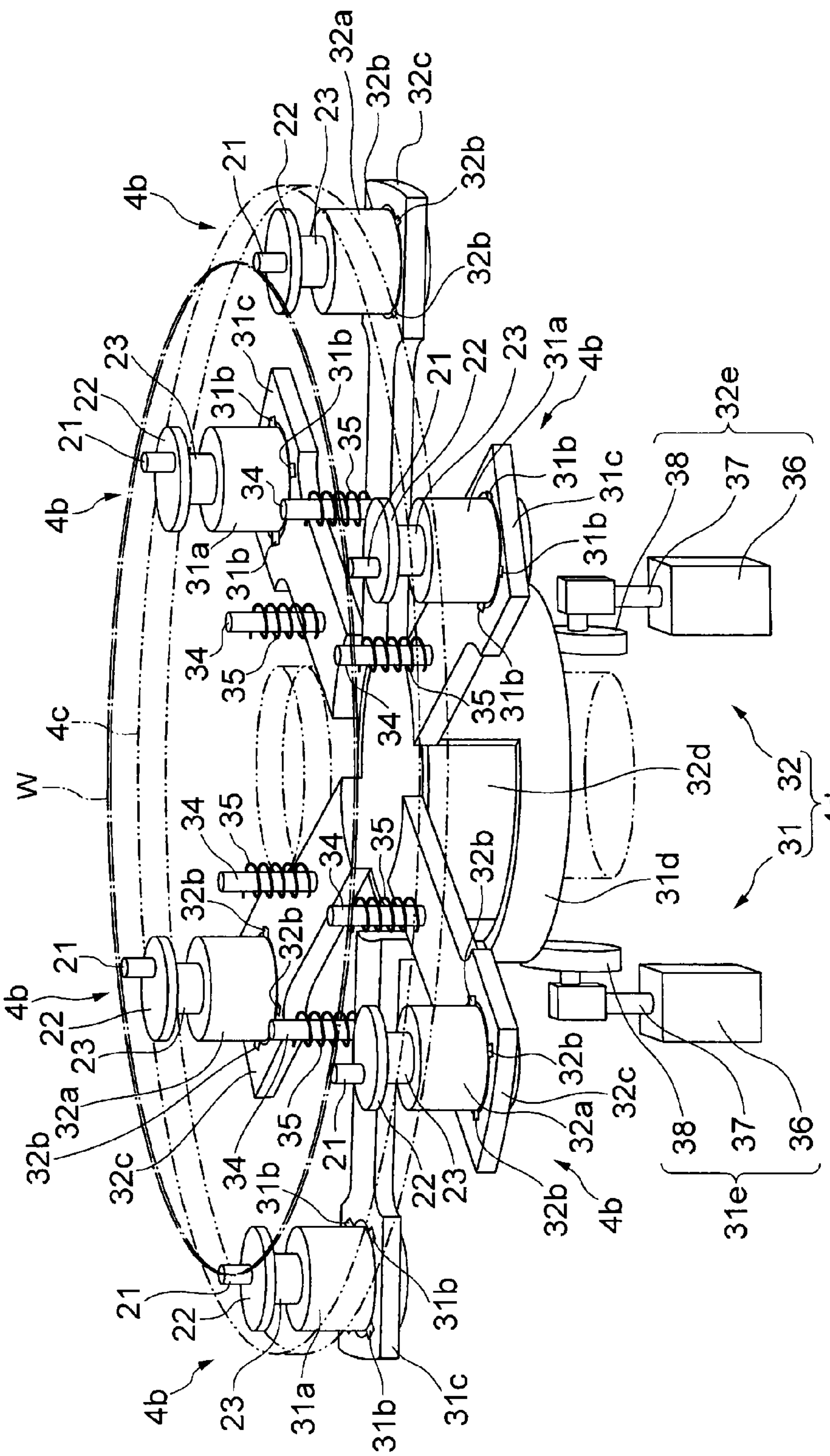
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FIG.3

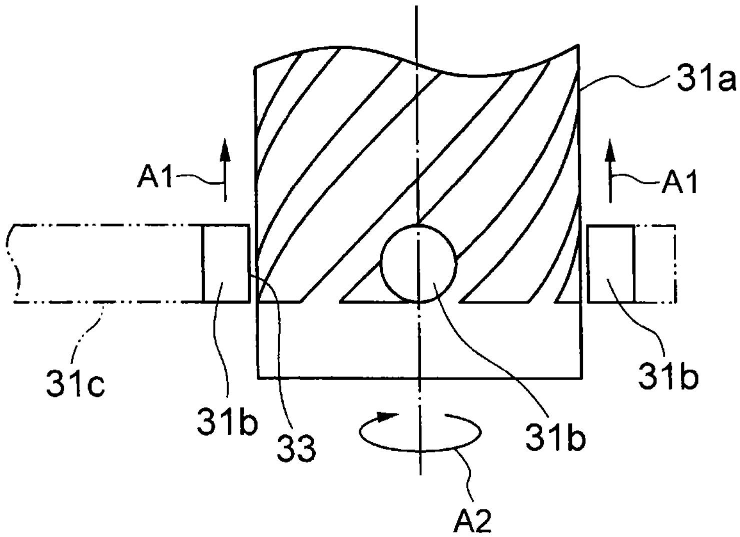


FIG.4

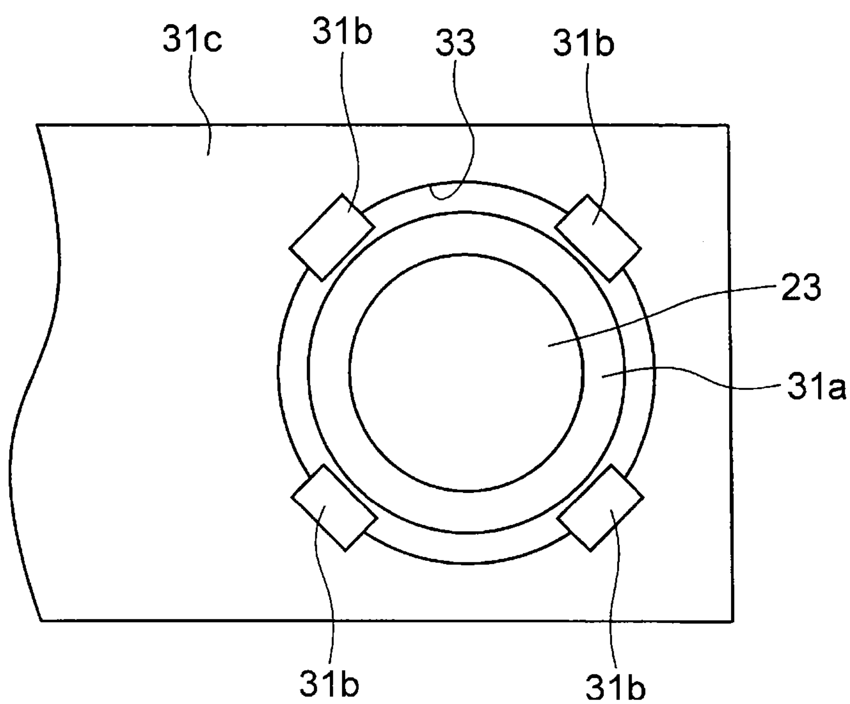
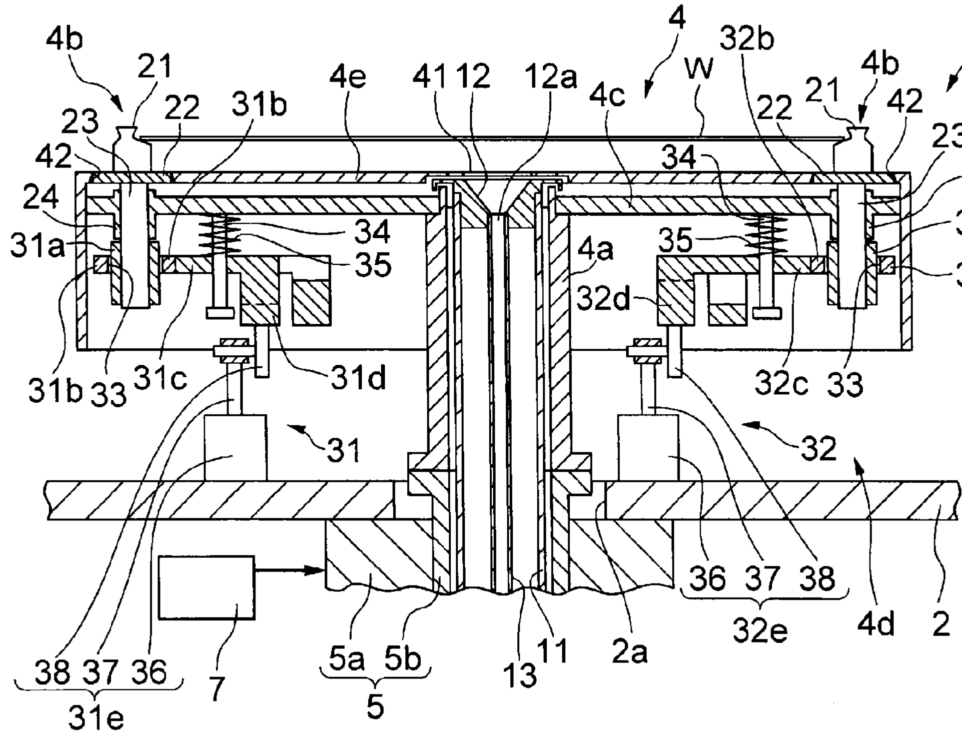


FIG.5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35
4a
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FIG.6

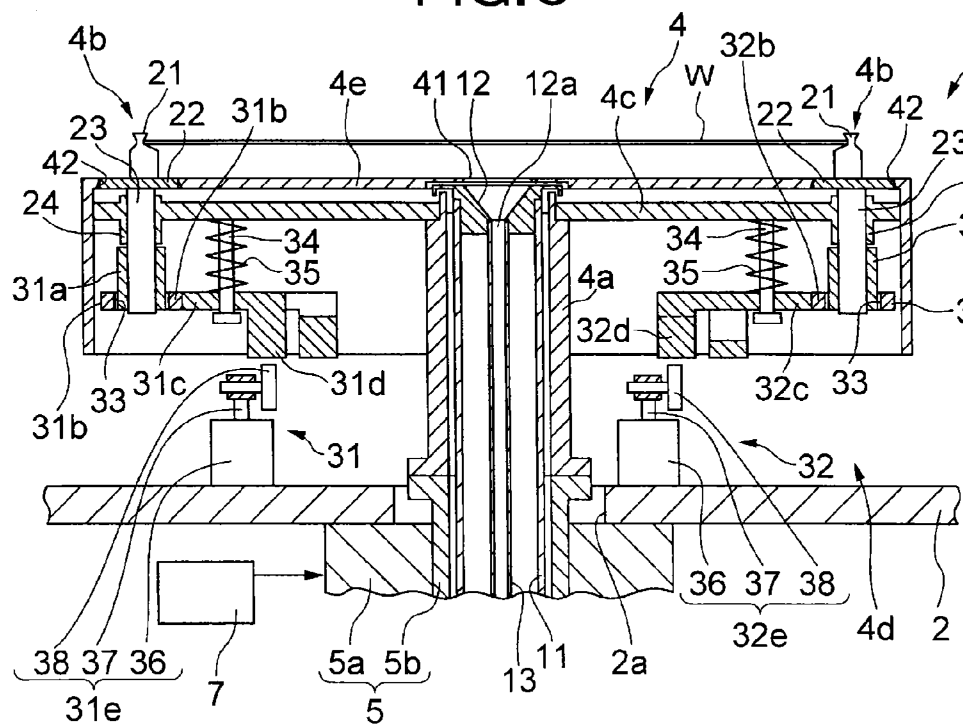
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FIG. 7

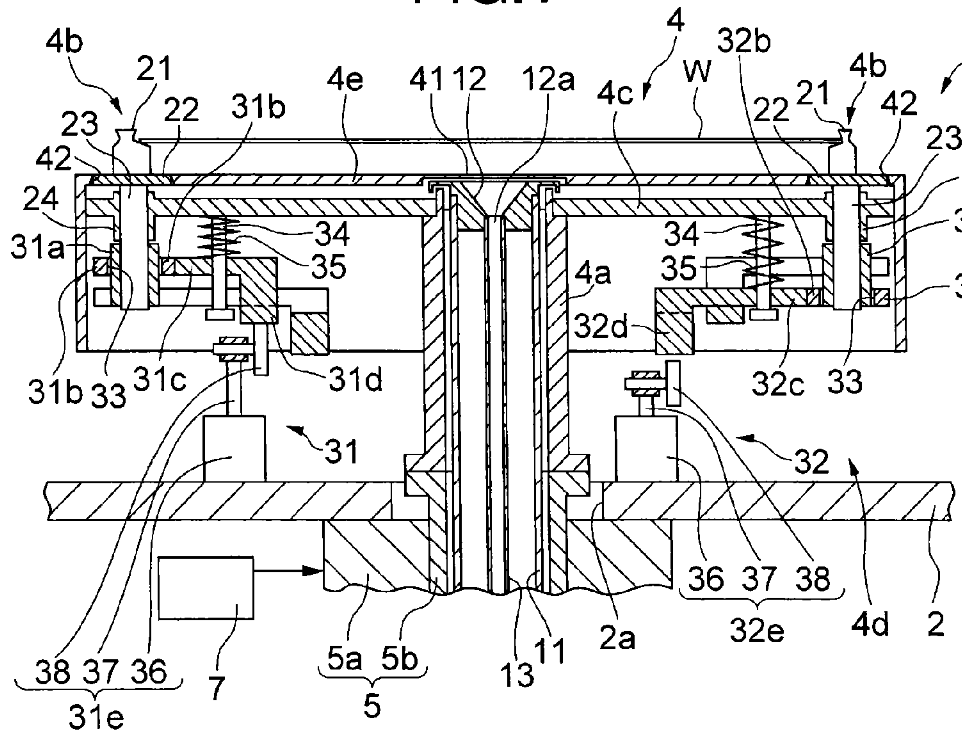
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FIG. 8

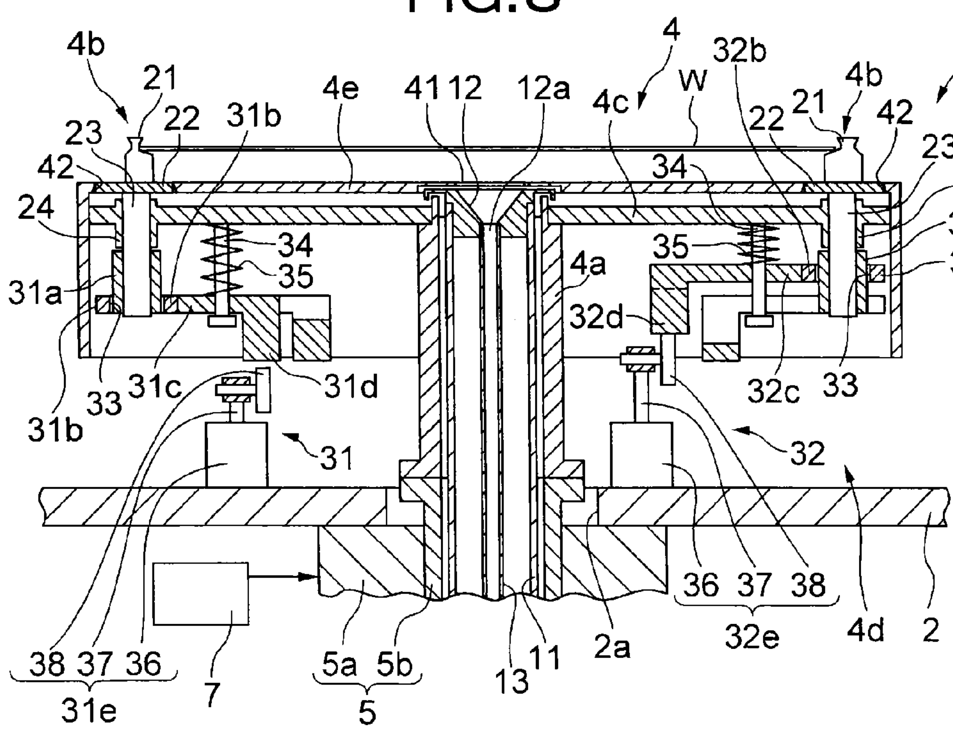
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FIG.9

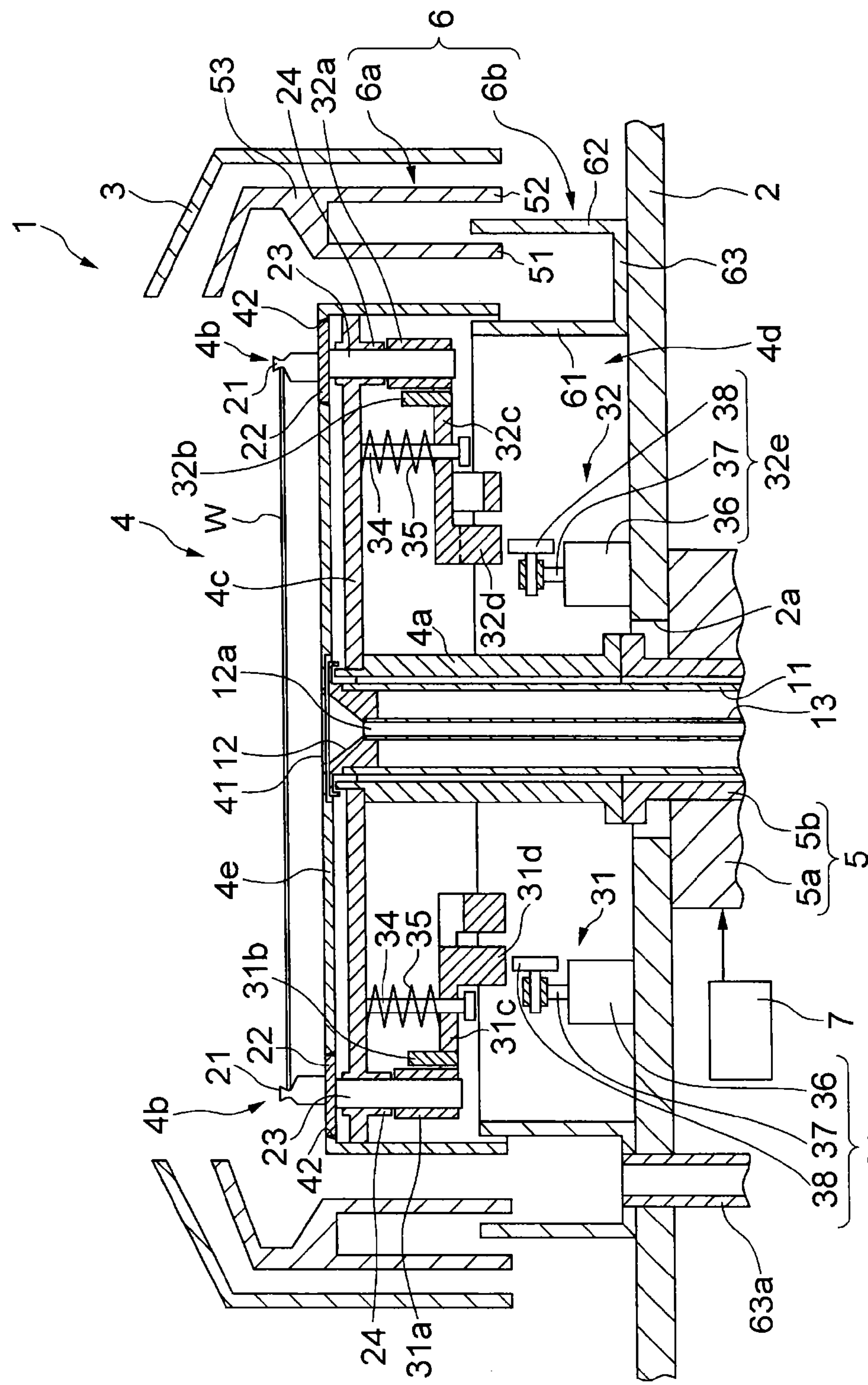
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FIG.10

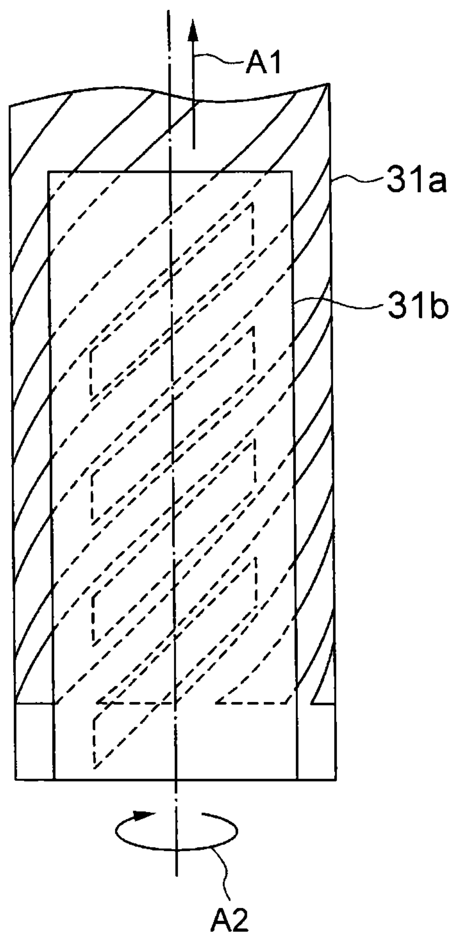
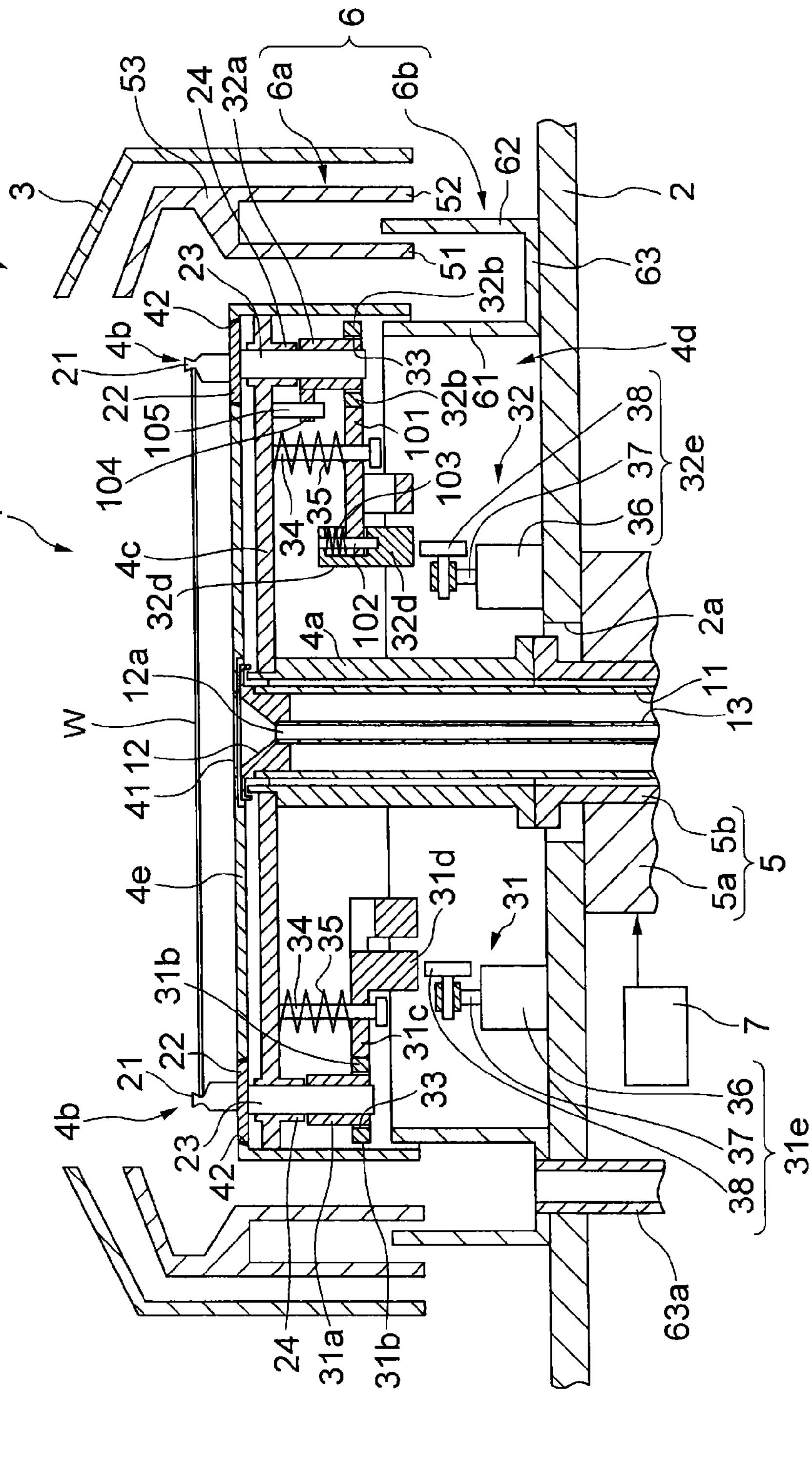


FIG.11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SPIN TREATMENT APPARATUS

CROSS-REFERENCE TO THE RELATED APPLICATION

This application is based on and claims the benefit of priority from Japanese Patent Applications No. 2013-198094, filed on Sep. 25, 2013 and No. 2014-162096, filed on Aug. 8, 2014; the entire contents of which are incorporated herein by reference.

FIELD

Embodiments discussed herein relate to a spin treatment apparatus.

BACKGROUND

A manufacturing process for a semiconductor device or a liquid crystal display device typically includes a film-forming process or a photolithography process to form a circuit pattern on a substrate such as a wafer or a glass plate. A wet process which is performed during the above processes and uses mainly liquid employs a spin treatment apparatus to subject the substrate to treatments such as a chemical treatment, a washing treatment, and a drying treatment. A spin treatment apparatus is an apparatus configured to perform a wet process by clamping the outer peripheral surface of a substrate, rotating the substrate about an axis perpendicular to the substrate at the center thereof, and supplying a treatment liquid (e.g., a chemical liquid or pure water) to the rotating substrate. Such a spin treatment apparatus generally includes a chuck mechanism configured to chuck the substrate.

As this chuck mechanism, multiple clamp pins are provided along the periphery of a substrate to clamp an outer peripheral portion of the substrate. The clamp pins are each integral with a rotary plate and a rotary shaft body, and provided on the rotary plate at a position offset by a certain distance from the rotation axis of the rotary shaft body. Pinions are fixed to the lower ends of the respective rotary shaft bodies, and mesh with a master gear whose rotation axis is perpendicular to the substrate at the center thereof. Hence, when the master gear rotates, the individual rotation shaft bodies rotate, causing the clamp pins to eccentrically rotate. The substrate can be clamped by these clamp pins.

Besides such a gear-type chuck mechanism, a magnet-type chuck mechanism has also been developed. In this magnet-type chuck mechanism, a circular plate is provided at the lower end of each rotary shaft body in place of the pinion described above, and the circular plate has a magnet perpendicular to the rotary shaft body. Bringing another magnet close to this circular plate causes the magnet on the circular plate to rotate with the circular plate due to the attractive force of the other magnet. The rotation of the magnet rotates the rotary shaft body, rotating the clamp pin eccentrically. This magnet-type chuck mechanism is capable of clamping the substrate with the clamp pins like the gear-type chuck mechanism. To unclamp the substrate, a magnet different from the other magnet described above is brought close to an unclamp position which is opposite from a clamp position described above.

However, these chuck mechanisms have their drawbacks. Specifically, the gear-type chuck mechanism reliably performs chuck operation with the clamp pins, but might generate dust due to wear of the gears. The magnet-type chuck mechanism generates no dust, but has the following problem. Specifically, due to the configuration in which the attractive force of another magnet causes the magnet on the circular plate to rotate with the circular plate, the distance between the magnetic poles attracting each other varies during the rotation of the magnet. Since the attractive force between the magnetic poles is inversely proportional to the square of the distance between the magnetic poles, decrease in the distance between the magnetic poles drastically increases the attractive force therebetween. For this reason, when the distance between the magnetic poles fluctuates, the clamp pins tend not to rotate uniformly. The positioning of the substrate is performed based on a single one of the clamp pins which has the smallest distance between the magnetic poles, and such non-uniformity in the pin rotation might cause displacement of the substrate from a predetermined position when clamped. It is therefore demanded to suppress both the generation of dust and the displacement of a substrate when clamped.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view showing the schematic configuration of a spin treatment apparatus according to a first embodiment.

FIG. **2** is a perspective view showing the schematic configuration of a chuck mechanism according to the first embodiment.

FIG. **3** is a diagram illustrating the positional relation between a magnet gear and rotation magnets according to the first embodiment.

FIG. **4** is a plan view showing the positional relation between the magnet gear and the rotation magnets according to the first embodiment.

FIG. **5** is a sectional view showing a state where all clamp pins of the spin treatment apparatus according to the first embodiment are out of substrate-clamping operation.

FIG. **6** is a sectional view showing a state where the entire clamp pins of the spin treatment apparatus according to the first embodiment are in substrate-clamping operation.

FIG. **7** is a sectional view showing a state where one set of clamp pins of the spin treatment apparatus according to the first embodiment is in substrate-clamping operation.

FIG. **8** is a sectional view showing a state where the other set of clamp pins of the spin treatment apparatus according to the first embodiment is in substrate-clamping operation.

FIG. **9** is a sectional diagram showing the schematic configuration of a spin treatment apparatus according to a second embodiment.

FIG. **10** is a diagram illustrating the positional relation between a magnet gear and a planar magnet according to the second embodiment.

FIG. **11** is a sectional diagram showing the schematic configuration of a spin treatment apparatus according to a third embodiment.

DETAILED DESCRIPTION

According to one embodiment, a spin treatment apparatus that performs a treatment while rotating a substrate, the apparatus includes: at least three clamp pins configured to come into contact with an outer peripheral surface of the substrate and clamp the substrate; a plurality of rotatable pin rotators provided for the respective clamp pins and each configured to retain the corresponding clamp pin at a position offset from a rotation axis of the pin rotator which is parallel with a rotation axis of the substrate; a plurality of magnet gears provided for the respective pin rotators around outer peripheral surfaces thereof and each having a magnetic-pole part formed spirally about the rotation axis of the pin rotator; a plurality of rotation magnets provided for the respective magnet gears and positioned so as to attract and be attracted by the magnetic-pole part of the corresponding magnet gear; and a movement mechanism configured to move the plurality of rotation magnets in the direction of the rotation axes of the pin rotators.

Various Embodiments will be described hereinafter with reference to the accompanying drawings.

First Embodiment

A first embodiment is described with reference to FIGS. **1** to **8**.

As shown in FIG. **1**, a spin treatment apparatus **1** according to the first embodiment includes: a base body **2** serving as the base of the spin treatment apparatus **1**; a cup body **3** with an open upper surface; a rotary body **4** configured to rotate inside the cup body **3**; a drive motor **5** configured to rotate the rotary body **4**; an annular liquid receiver **6** surrounding the rotary body **4**; and a controller **7** (e.g., a microcomputer) configured to control each part.

The base body **2** has a plate shape, and a through-hole **2***a* is formed at a center portion of a bottom surface of the base body **2**. In addition, drainage tubes (not shown) configured to drain sump solution are connected to a peripheral edge portion of the base body **2** at predetermined intervals.

The cup body **3** has a tubular (annular) shape with an open upper surface and an open lower surface, and accommodates thereinside the rotary body **4**, the liquid receiver **6**, and the like. An upper end portion of the cup body **3** slants radially inward over the entire circumference. The cup body **3** can be moved up and down by an up-and-down mechanism (not shown) such as a cylinder.

The rotary body **4** includes: a cylindrical power transmission body **4***a* configured to transmit power from the drive motor **5**; multiple (e.g., six) clamp portions **4***b* configured to clamp a substrate W; a rotary plate **4***c* configured to retain the clamp portions **4***b*; a rotation mechanism **4***d* for causing the clamp portions **4***b* to clamp the substrate W; and a cover **4***e* configured to cover these parts.

The drive motor **5** includes a tubular stator **5***a* and a tubular rotor **5***b* rotatably inserted in the stator **5***a*. The drive motor **5** is a motor serving as a drive source for rotating the substrate W clamped by the clamp portions **4***b*. The drive motor **5** is electrically connected to the controller **7**, and is driven as controlled by the controller **7**.

The power transmission body **4***a* is fixed to the rotor **5***b* of the drive motor **5** such that the rotation axis (center axis) of the power transmission body **4***a* coincides with the rotation axis of the drive motor **5**. The power transmission body **4***a* rotates along with the rotor **5***b*. In other words, the power transmission body **4***a* is rotated by the drive motor **5**.

A stationary shaft **11** which does not rotate is provided in a space inside the power transmission body **4***a* and the rotor **5***b*. This stationary shaft **11** is provided with a nozzle head **12** at an upper portion thereof. A nozzle **12***a* is formed at the nozzle head **12**. The nozzle **12***a* is configured to eject a treatment liquid (e.g., a chemical liquid or pure water) toward the back surface of the substrate W clamped by the clamp portions **4***b*, and is connected to a supply pipe **13** through which the treatment liquid flows. In addition, although not shown, a nozzle for supplying a treatment liquid (e.g., a chemical liquid or pure water) to the front surface of the substrate W is also provided above the rotary body **4**.

As shown in FIGS. **1** and **2**, the clamp portions **4***b* are placed at predetermined intervals, e.g. at regular intervals, circumferentially about the rotation axis of the power transmission body **4***a*. When put into operation, these clamp portions **4***b* implement a chuck mechanism for clamping the substrate W with the center of the substrate W being aligned with the rotation axis of the power transmission body **4***a*.

Each clamp portion **4***b* includes a clamp pin **21** configured to come into contact with the substrate W, a rotary plate **22** configured to retain the clamp pin **21** and rotate, and a pin rotator **23** configured to retain the rotary plate **22** and rotate. The clamp pin **21** is inversely tapered and is integral with the rotary plate **22** by being fixed to an upper surface of the rotary plate **22** with its center being offset from the rotation axis of the pin rotator **23** by a certain distance. The clamp pin **21** eccentrically rotates as the pin rotator **23** rotates. The pin rotator **23** is rotatably retained by a tubular support portion **24** of the rotary plate **4***c*.

The clamp portion **4***b* operates as follows. When the pin rotator **23** rotates in a direction for clamping the substrate W, the clamp pin **21** on the rotary plate **22** eccentrically rotates, coming into contact with the outer peripheral surface (end surface) of the substrate W. Likewise, the clamp pins **21** of the other clamp portions **4***b* come into contact with the outer peripheral surface of the substrate W. Thus, the clamp pins **21** clamp the substrate W while aligning the center of the substrate W with the rotation axis of the power transmission body **4***a*. On the other hand, when the pin rotator **23** rotates in an unclamping direction which is the opposite from the clamping direction, the clamp pin **21** on the rotary plate **22** rotates in a direction opposite to the aforementioned direction and moves away from the outer peripheral surface of the substrate W. The clamp pins **21** of the other clamp portions **4***b* also move away from the outer peripheral surface of the substrate W, unclamping the clamped substrate W.

The rotary plate **4***c* is integral with the power transmission body **4***a* by being fixed to the outer peripheral surface of the power transmission body **4***a*. The rotary plate **4***c* rotates along with the power transmission body **4***a* while retaining the clamp portions **4***b*. When the rotary plate **4***c* rotates along with the power transmission body **4***a* as the power transmission body **4***a* rotates, the clamp portions **4***b* also rotate about the rotation axis of the power transmission body **4***a*. The tubular support portions of the rotary plate **4***c* are provided at an outer peripheral portion of the circular rotary plate **4***c* at regular intervals along the circumference thereof about the rotation axis of the power transmission body **4***a*.

The rotation mechanism **4***d* includes a first rotation mechanism **31** corresponding to a set of three clamp portions **4***b* which are alternate ones of the clamp portions **4***b* arranged in the rotation direction of the power transmission body **4***a* and a second rotation mechanism **32** corresponding to the other set of three clamp portions **4***b*. In a case where there are six clamp portions **4***b*, the first rotation mechanism **31** and the second rotation mechanism **32** have the same structure.

The first rotation mechanism **31** includes: magnet gears **31***a* each provided around an outer peripheral surface of the pin rotator **23** of a corresponding one of the clamp portions **4***b*; multiple rotation magnets **31***b* corresponding to each of the magnet gears **31***a*; a set of up-and-down arms **31***c* (three up-and-down arms **31***c* in this embodiment) each retaining the rotation magnets **31***b* and configured to move up and down; an up-and-down ring **31***d* integral with the up-and-down arms **31***c*; and an up-and-down mechanism **31***e* configured to move the up-and-down ring **31***d* in a direction of the rotation axes of the pin rotators **23**.

As shown in FIGS. **3** and **4**, each magnet gears **31***a* is a cylindrical magnet gear having north magnetic-pole parts (e.g., bands) and south magnetic-pole parts (e.g., bands) alternately arranged in a spiral manner over the cylindrical surface of the pin rotator **23**. The magnet gear **31***a* is, as shown in FIGS. **1** and **2**, fixed to a lower portion of the outer peripheral surface of the pin rotator **23**, and rotates together with the pin rotator **23**. The magnet gear **31***a* is attached to the pin rotator **23** such that there is no backlash or play in a direction of the rotation axis of the pin rotator **23** (a vertical direction).

As shown in FIGS. **3** and **4**, the multiple (e.g., four) rotation magnets **31***b* are arranged along the outer peripheral surface of the magnet gear **31***a* at positions at which they attract the magnetic-pole parts on the surface of the magnet gear **31***a*. The rotation magnets **31***b* are fixed to the up-and-down arm **31***c*. The rotation magnets **31***b* are arranged in an edge portion of a through-hole **33** formed in the up-and-down arm **31***c*, at regular intervals or at regular intervals with some angle added. In this through-hole **33**, the magnet gear **31***a* and the pin rotator **23** are inserted. Such rotation magnets **31***b* are provided for each up-and-down arm **31***c*.

When the rotation magnets **31***b* move up in a direction of arrow A1 shown in FIG. **3**, the magnet gear **31***a* rotates in a direction of arrow A2 shown in FIG. **3**. Since the rotation magnets **31***b* and the magnetic-pole parts of the magnet gear **31***a* attract each other, the rotation magnets **31***b* move up while attracting the magnetic-pole parts of the magnet gear **31***a*. In addition, because of the spiral arrangement of the magnetic-pole parts of the magnet gear **31***a*, when the rotation magnets **31***b* move up in the direction of arrow A1, the magnet gear **31***a* rotate in the direction of arrow A2 to maintain the state in which the rotation magnets **31***b* and the magnetic-pole parts of the magnet gear **31***a* attract each other. During the rotation of the magnet gear **31***a* caused by the elevation of the rotation magnets **31***b*, there is no change in the distance between the magnetic poles, i.e., the distance between the magnet gear **31***a* and the rotation magnets **31***b*. Hence, the attractive force is maintained constant. When the rotation magnets **31***b* move down in a direction opposite from arrow A1, the magnet gear **31***a* rotates in a direction opposite from arrow A2.

Referring back to FIGS. **1** and **2**, the set of up-and-down arms **31***c* are connected at their base portions to the up-and-down ring **31***d* which is a ring-shaped member. These up-and-down arms **31***c* are supported by respective up-and-down shafts **34** fixed to the rotary plate **4***c*, and are slidable relative to the up-and-down shafts **34**. The up-and-down shafts **34** are attached to the rotary plate **4***c* in such a manner as to be parallel with the rotation axis of the power transmission body **4***a*. The up-and-down shafts **34** allow the up-and-down arms **31***c* to move up and down with their postures being maintained to be perpendicular to the rotation axis of the power transmission body **4***a*. A clamp spring **35** is provided to each of the up-and-down shafts **34**. The clamp spring **35** is located between the rotary plate **4***c* and the corresponding up-and-down arm **31***c* and presses the up-and-down arm **31***c* down with a certain spring force.

The up-and-down ring **31***d* is a ring-shaped member that unites and supports the set of up-and-down arms **31***c*. The up-and-down ring **31***d* has the power transmission body **4***a* inserted therethrough and is movable in the direction of the rotation axis of the power transmission body **4***a* (the vertical direction) along the outer peripheral surface of the power transmission body **4***a*. The up-and-down ring **31***d* unites the three up-and-down arms **31***c*, and at the same time, enables them to move (up and down).

The up-and-down mechanism **31***e* has a cylinder **36** such as an air cylinder, a cylinder shaft **37** configured to be moved up and down by the cylinder **36**, and an up-and-down roller **38** attached to a tip portion of the cylinder shaft **37**. The cylinder **36** is fixed to the base body **2**. The up-and-down roller **38** is provided at an end portion of the cylinder shaft **37** so that the up-and-down roller **38** comes into contact with the lower surface of the up-and-ring **31***d* when moving up. The up-and-down ring **31***d* moves up in the direction of the rotation axis of the power transmission body **4***a* when the up-and-down roller **38** moves up and contacts the lower surface of the up-and-down ring **31***d* to push the up-and-down ring **31***d* up in the direction of the rotation axis of the power transmission body **4***a*.

When the up-and-down mechanism **31***e* elevates the up-and-down ring **31***d* in the direction of the rotation axis of the power transmission body **4***a*, the set of (three) up-and-down arms **31***c* moves up in the direction of the rotation axis of the power transmission body **4***a*. Thus, the rotation magnets **31***b* fixed to each of the up-and-down arms **31***c* move up while maintaining the state of attracting the magnetic-pole parts of the magnet gear **31***a*, as described earlier. When the rotation magnets **31***b* move up, the magnet gear **31***a* rotates to maintain the state of attracting the rotation magnets **31***b*. In this event, the distance between the magnetic poles, i.e., the distance between the magnet gear **31***a* and the rotation magnets **31***b* does not change. Hence, the magnet gear **31***a* can rotate while maintaining a constant attractive force, allowing the corresponding clamp pin **21** to rotate at a constant velocity.

The attractive force between the magnet gear **31***a* and the rotation magnets **31***b* is adjusted by changing, for example, the number and arrangement of the magnets so that, when the up-and-down arm **31***c* is lowered by being pushed down by the force of the compressed clamp spring **35** and thereby lowers the rotation magnets **31***b*, the magnet gear **31***a* may rotate while constantly maintaining the state (relation) in which the magnet gear **31***a* and the rotation magnets **31***b* moving down attract and face each other. Thereby, while the magnet gear **31***a* rotates when the rotation magnets **31***b* move down, the magnet gear **31***a* and the rotation magnets **31***b* constantly maintain the state of attracting and facing each other. For this reason, the up-and-down arm **31***c* moves down due to the spring force of the clamp spring **35**, and the rotation magnets **31***b* accordingly move down. In this event, the clamp spring **35** gradually extends as the up-and-down arm **31***c* moves down, pushing the up-and-down arm **31***c* down with less force. The up-and-down arm **31***c* is designed to eventually stop moving down once this force of the clamp spring **35** pushing the up-and-down arm **31***c* becomes smaller than the attractive force acting between the magnet gear **31***a* and the rotation magnets **31***b* (the attractive force constantly maintaining the state in which the magnet gear **31***a* and the rotation magnets **31***b* attract and face each other). In this way, the spring force (pushing force) of the clamp springs **35** pushing the up-and-down arms **31***c* down can be used as clamping force with which the clamp pins **21** clamp the substrate W.

Moreover, the set of up-and-down arms **31***c* on which the force of the clamp springs **35** are acting can move up when the up-and-down ring **31***d* is elevated by the up-and-down mechanism **31***e*. Then, the rotation magnets **31***b* fixed to the set of up-and-down arms **31***c* move up to rotate the magnet gears **31***a*, which consequently rotates the clamp pins **21** which is clamping the substrate W by use of the force of the clamp springs **35**. The rotation of the clamp pins **21** unclamps the substrate W. Note that the force of the clamp springs **35** pushing down the up-and-down arms **31***c* acts as the clamping force. Herein, to unclamp the substrate W, the up-and-down mechanism **31***e* elevates the up-and-down ring **31***d*, compressing the clamp springs **35** and elevating the set of up-and-down arms **31***c* to thereby rotate the three clamp pins **21**.

Conversely, when the up-and-down mechanism **31***e* lowers the up-and-down ring **31***d*, the set of up-and-down arms **31***c* moves down, and consequently the magnet gears **31***a* rotate reversely, bringing the clamp pins **21** into contact with the end portion of the substrate W. When the clamp pins **21** clamp the substrate W, the set of up-and-down arms **31***c* stops moving down, and the clamp pins **21** stop while applying force to the substrate W with the pressure of the clamp springs **35**. At the same time that the up-and-down mechanism **31***e* lowers the up-and-down ring **31***d*, the clamp springs **35** extend to generate force of pushing the set of up-and-down arms **31***c* down. The magnet gears **31***a* are rotated by this force, and the three clamp pins **21** eccentrically rotate to come into compact with the substrate W and clamp the substrate W. When the clamp pins **21** come into contact with the substrate W, the clamp springs **35** do not extend all the way, but stop halfway.

Since the cylinder **36** is configured to elevate or lower the cylinder shaft **37** by a constant amount irrespective of whether the set of the up-and-down arms **31***c* moves down and stops. Hence, the cylinder shaft **37** stops with a gap existing between the up-and-down ring **31***d* and the up-and-down roller **38**. In other words, when the cylinder shaft **37** is at the lowermost position, the up-and-down roller **38** is not in contact with the up-and-down ring **31***d*, but is separated from the lower surface of the up-and-down ring **31***d*. Thereby, during the rotation of the rotary body **4**, the up-and-down ring **31***d* can rotate smoothly without touching the up-and-down roller **38**. In addition, it is also possible to elevate the up-and-down ring **31***d* during the rotation of the rotary body **4** by bringing the up-and-down roller **38** into contact with the lower surface of the up-and-down ring **31***d*. Thus, the clamp pins **21** can be put into or out of operation irrespective of whether the rotary body **4** is rotating or is stopped.

The second rotation mechanism **32** includes: magnet gears **32***a* each provided on an outer peripheral surface of the pin rotator **23** of a corresponding one of the clamp portions **4***b*; multiple rotation magnets **32***b* corresponding to each of the magnet gears **32***a*; a set of up-and-down arms **32***c* (three up-and-down arms **32***c* in this embodiment) each retaining the rotation magnets **32***b* and configured to move up and down; an up-and-down ring **32***d* integral with the up-and-down arms **32***c*; and an up-and-down mechanism **32***e* configured to move the up-and-down ring **32***d* in the direction of the rotation axes of the pin rotators **23**. Since the second rotation mechanism **32** has the same configuration as the first rotation mechanism **31**, a description of the portions of the second rotation mechanism **32** is omitted.

Note that the set of up-and-down arms **31***c* and the up-and-down ring **31***d* of the first rotation mechanism **31** function as a retainer, and this retainer and the up-and-down mechanism **31***e* function as a movement mechanism for moving the rotation magnets **31***b* in the direction of the rotation axis of the corresponding pin rotator **23**. Similarly, the set of up-and-down arms **32***c* and the up-and-down ring **32***d* of the second rotation mechanism **32** function as a retainer, and this retainer and the up-and-down mechanism **32***e* function as a movement mechanism for moving the rotation magnets **32***b* in the direction of the rotation axis of the corresponding pin rotator **23**.

The number of the spiral magnetic-pole parts (e.g., bands) and the number of the rotation magnets **31***b* in the first rotation mechanism **31** or the second rotation mechanism **32** are not limited and each may be one as long as the pin rotators **23** can be rotated by the magnet gears **31***a* or **32***a*. It is however desirable to have two or more combinations of the spiral magnetic-pole part and the rotation magnet **31***b* to improve the stability of the rotation of the pin rotator **23**.

The cover **4***e* is a case with an open lower surface, and covers the aforementioned parts configured to rotate with the rotation of the power transmission body **4***a* in order to prevent occurrence of turbulent flow. The cover **4***e* has an opening portion **41** configured to allow the treatment liquid ejected from the nozzle **12***a* of the nozzle head **12** to pass up therethrough, and multiple through-holes **42** in which the rotary plates **22** of the clamp portions **4***b* are inserted.

The liquid receiver **6** includes an annular movable liquid receiver (first liquid receiver) **6***a* and an annular stationary liquid receiver (second liquid receiver) **6***b*. The movable liquid receiver **6***a* and the stationary liquid receiver **6***b* are provided to surround the rotary body **4** with their centers coinciding with the rotation axis of the rotary body **4**, i.e., the rotation axis of the power transmission body **4***a*.

The movable liquid receiver **6***a* has an annular inner wall **51**, an annular outer wall **52**, and an annular upper-surface wall **53** connecting the upper end portions of the inner wall **51** and the outer wall **52** together. The upper end portion of the inner wall **51** slants radially inward over the entire circumference. The annular inner wall **51** and outer wall **52** have an annular space of a predetermined width in between.

An up-and-down mechanism (not shown) such as a cylinder enables the movable liquid receiver **6***a* to move up and down, or specifically, between a liquid receiving position (see FIG. **1**) at which its surface on the rotary body **4** side (inner surface) receives liquid from the substrate W and a lid-closing position at which the movable liquid receiver **6***a* prevents ingress of liquid to the stationary liquid receiver **6***b*. The upper end portion of the movable liquid receiver **6***a* is higher than the height of the substrate W on the rotary body **4** at the liquid receiving position and is lower than the height of the substrate W on the rotary body **4** at the lid-closing position. Hence, to collect a treatment liquid, the movable liquid receiver **6***a* moves up to the liquid-receiving position to receive the liquid from the substrate W on the rotary body **4** and passes the liquid into the stationary liquid receiver **6***b*.

The stationary liquid receiver **6***b* has an annular inner wall **61**, an annular outer wall **62**, and a bottom-surface wall **63** connecting the lower end portions of the inner wall **61** and the outer wall **62** together. Multiple collection pipes **63***a* for collecting a chemical liquid are connected to the bottom-surface wall **63** along the circumference thereof at predetermined intervals. The annular inner wall **61** and outer wall **62** have an annular space of a predetermined width in between.

The stationary liquid receiver **6***b* is placed such that the inner wall **51** of the movable liquid receiver **6***a* and the outer peripheral wall of the cover **4***e* are located between the annular inner wall **61** and the annular outer wall **62**. The stationary liquid receiver **6***b* can collect the liquid received by the inner surface of the movable liquid receiver **6***a*. More specifically, the stationary liquid receiver **6***b* can collect the liquid which has hit the inner surface of the movable liquid receiver **6***a*, in the space between the two annular walls: the inner wall **61** and the outer wall **62**.

The stationary liquid receiver **6***b* has a structure in which the movable liquid receiver **6***a* which is down at the lid-closing position serves as a lid closing the opening of the stationary liquid receiver **6***b*. When down at the lid-closing position to serve as the lid closing the opening of the stationary liquid receiver **6***b*, the movable liquid receiver **6***a* prevents liquid from flowing into the stationary liquid receiver **6***b*. Since the annular outer wall **62** is covered by the outer wall **52** of the movable liquid receiver **6***a* to ensure the prevention of liquid ingress to the stationary liquid receiver **6***b*, mixing of liquids can be prevented.

Next, spin treatment operation of the spin treatment apparatus **1** configured as above is described.

The spin treatment operation has the following steps: placing the substrate W onto the clamp pins **21** as shown in FIG. **5**, clamping the substrate W with all the clamp pins **21** before treatment as shown in FIG. **6**, putting a set of clamp pins **21** out of clamping operation during the treatment as shown in FIG. **7**, putting another set of clamp pins **21** out of clamping operation during the treatment as shown in FIG. **8**, and putting all the clamp pins **21** out of clamping operation after the treatment as shown in FIG. **5**.

As shown in FIG. **5**, in the step of placing the substrate W on the clamp pins **21**, all the clamp pins **21** of the clamp portions **4***b* are out of operation of clamping the substrate W. Then, a conveyance mechanism (not shown) such as a robot with a robot hand places the substrate W onto slanted surfaces of the clamp pins **21**. In this state, the up-and-down ring **31***d* and the up-and-down ring **32***d* are up by elevation of the up-and-down rollers **38** of the up-and-down mechanism **31***e* and the up-and-down mechanism **32***e*, respectively, so that the two sets of up-and-down arms **31***c* and **32***c* are up in the direction of the rotation axis. Thus, the rotation magnets **31***b* and **32***b* fixed to the two sets of up-and-down arms **31***c* and **32***c* have also been moved up to cause the magnet gears **31***a* and **32***a* to rotate a certain amount. The clamp pins **21** have rotated along with rotation of the pin rotators **23** and the rotary plates **22**, and are stopped at positions for unclamping the substrate W.

Next, as shown in FIG. **6**, in the step of clamping the substrate W with all the clamp pins **21** before treatment, the up-and-down roller **38** of the up-and-down mechanism **31***e* and the up-and-down roller **38** of the up-and-down mechanism **32***e* move down to lower the up-and-down ring **31***d* and the up-and-down ring **32***d*, respectively, from the aforementioned state in FIG. **5**. Thereby, the two sets of up-and-down arms **31***c* and **32***c* move down in the direction of the rotation axis. Thereby, the rotation magnets **31***b* fixed to the two sets of up-and-down arms **31***c* and **32***c* also move down, consequently rotating the magnet gears **31***a* and **32***a*. Then, all the clamp pins **21** are rotated by the rotation of the pin rotators **23** and the rotary plates **22**, and stop after clamping the substrate W with the clamping force of the clamp springs **35**. At the same time that the up-and-down mechanisms **31***e* and **32***e* lower the up-and-down rings **31***d* and **32***d*, the clamp springs **35** extend, exerting a force pushing down the two sets of up-and-down arms **31***c* and **32***c*. By using this pushing force to rotate the magnet gears **31***a*, the six clamp pins **21** eccentrically rotate to come into contact with the substrate W, and clamp the substrate W. When the clamp pins **21** come into contact with the substrate W, the clamp springs **35** do not extend all the way, but stop halfway.

Here, all the clamp pins **21** eccentrically rotate and come into contact with the outer peripheral surface of the substrate W to clamp the substrate W. When the up-and-down rings **31***d* and **32***d* move down, the set of up-and-down arms **31***c* and the set of up-and-down arms **32***c* integral with the respective up-and-down rings **31***d* and **32***d* synchronously move down while keeping their horizontal posture. Thus, the clamp pins **21** (three clamp pins **21** in this embodiment) corresponding to each of the set of up-and-down arms **31***c* and the set of up-and-down arms **32***c* also synchronously rotate. Thereby, the substrate W is clamped with all the clamp pins **21** with the center of the substrate W being aligned with the rotation axis (the substrate W is centered with all the clamp pins **21**). Note that, for the clamping of the substrate W, the up-and-down mechanisms **31***e* and **32***e* may be operated at the same time in synchronization, or may be actuated at different timings.

Next, as shown in FIG. **7**, in the step of putting one set of the clamp pins **21** out of clamping operation during the treatment, the up-and-down roller **38** of the up-and-down mechanism **31***e* moves up to elevate the up-and-down ring **31***d* from the aforementioned state in FIG. **6**, thereby elevating the set of up-and-down arms **31***c* in the direction of the rotation axis. Thus, the rotation magnets **31***b* fixed to the set of up-and-down arms **31***c* also move up to cause the magnet gears **31***a* to rotate a certain amount. The pin rotators **23** and the rotary plates **22** are thereby rotated to rotate the clamp pins **21**, and the clamp pins **21** are stopped at positions for unclamping the substrate W. When the one set of clamp pins **21** is put out of clamping operation in this way, the drive motor **5** rotates the rotary body **4**, and a treatment liquid (e.g., a chemical liquid or pure water) is started to be supplied to the upper surface and the lower surface of the rotating substrate W. Note that the one set of clamp pins **21** can be put out of clamping operation at various timings. The one set of clamp pins **21** may be put out of clamping operation before the substrate W is rotated or after the rotation of the substrate W stabilizes.

During the supply of the treatment liquid, the treatment liquid supplied to the upper and lower surfaces of the substrate W flows radially outward of the substrate W and flies from the outer peripheral edge of the substrate W due to the centrifugal force and airflows generated by the rotation. In this event, by moving the movable liquid receiver **6***a* (up and down), the flow channel of the treatment liquid can be switched between a collection flow channel for collecting the treatment liquid and a drainage flow channel for draining the treatment liquid. When the liquid flow channel is the collection flow channel, i.e., the movable liquid receiver **6***a* is up at the liquid receiving position to collect the treatment liquid (see FIG. **1**), liquid flying from the end portion of the substrate W hits the inner surface of the movable liquid receiver **6***a*, flows along the inner surface, is collected in the stationary liquid receiver **6***b*, and is then collected through the collection pipes **63***a*. On the other hand, when the liquid flow channel is the drain flow channel, i.e., the movable liquid receiver **6***a* is down at the lid-closing position to drain the treatment liquid, liquid flying from the end portion of the substrate W hits the inner peripheral surface of the cup body **3**, flows through a flow channel extending from the cup body **3** to the base body **2**, and is then drained through the drainage tubes.

Thereafter, as shown in FIG. **8**, in the step of putting the other set of clamp pins **21** out of clamping operation during the treatment, the up-and-down roller **38** of the up-and-down mechanism **31***e* moves down to lower the up-and-down ring **31***d* from the aforementioned state in FIG. **7**, thereby lowering the set of up-and-down arms **31***c* in the direction of the rotation axis. Thus, the rotation magnets **31***b* fixed to the set of up-and-down arms **31***c* also move down to cause the magnet gears **31***a* to rotate. The pin rotators **23** and the rotary plates **22** thereby rotate to rotate the clamp pins **21**, and the clamp pins **21** are stopped after clamping the substrate W with the clamping force of the clamp springs **35**. At the same time that the up-and-down mechanism **31***e* lowers the up-and-down ring **31***d*, the clamp springs **35** extend, exerting a force pushing down the one set of up-and-down arms **31***c*. By using this pushing force to rotate the magnet gears **31***a*, the three clamp pins **21** eccentrically rotate to come into contact with the substrate W, and clamp the substrate W. When the clamp pins **21** come into contact with the substrate W, the clamp springs **35** do not extend all the way, but stop halfway.

Next, the up-and-down roller **38** of the up-and-down mechanism **32***e* moves up to elevate the up-and-down ring **32***d*, thereby elevating the set of up-and-down arms **32***c* in the direction of the rotation axis. The rotation magnets **32***b* fixed to the set of up-and-down arms **32***c* thereby move up, causing the magnet gears **32***a* to rotate a certain amount. The pin rotators **23** and the rotary plates **22** thereby rotate to rotate the clamp pins **21**, and the clamp pins **21** are stopped at positions for unclamping the substrate W. Although the other set of clamp pins **21** is thus put out of clamping operation, the rotary body **4** is still being rotated by the drive motor **5** with the treatment liquid continuing being supplied to the upper (front) and lower (back) surfaces of the rotating substrate W.

When a liquid treatment and a rinsing treatment with pure water are all finished, the supply of the treatment liquid is stopped, and as shown in FIG. **6**, the substrate W is once again clamped with all the clamp pins **21**. To be more specific, the up-and-down roller **38** of the up-and-down mechanism **32***e* moves down to lower the up-and-down ring **32***d* from the aforementioned state in FIG. **8**, thereby lowering the set of up-and-down arms **32***c* in the direction of the rotation axis. The rotation magnets **32***b* fixed to the set of up-and-down arms **32***c* thereby move down, causing the magnet gears **32***a* to rotate. The pin rotators **23** and the rotary plates **22** thereby rotate to rotate the clamp pins **21**, and the clamp pins **21** are stopped after clamping the substrate W with the clamping force of the clamp springs **35**. At the same time that the up-and-down mechanism **32***e* lowers the up-and-down ring **32***d*, the clamp springs **35** extend, exerting a force pushing down the set of up-and-down arms **32***c*. By using this pushing force to rotate the magnet gears **32***a*, the three clamp pins **21** eccentrically rotate to come into contact with the substrate W, and clamp the substrate W. When the clamp pins **21** come into contact with the substrate W, the clamp springs **35** do not extend all the way, but stop halfway.

Thereafter, the rotary body **4** rotates at a speed higher than that during the liquid supply stage (spin dry). After a predetermined period of dry treatment, the substrate W is stopped rotating while maintaining the aforementioned state shown in FIG. **6**. Finally, after the rotation of the substrate W is stopped, all the clamp pins **21** are put out of operation of clamping the substrate W as shown in FIG. **5**. In this unclamping step, the up-and-down roller **38** of the up-and-down mechanism **31***e* and the up-and-down roller **38** of the up-and-down mechanism **32***e* move up to elevate the up-and-down ring **31***d* and the up-and-down ring **32***d*, respectively, so that the two sets of up-and-down arms **31***c* and **32***c* move up in the direction of the rotation axis. Thereby, the rotation magnets **31***b* and **32***b* fixed to those two sets of up-and-down arms **31***c* and **32***c* also move up to cause the magnet gears **31***a* and **32***a* to rotate a certain amount. The pin rotators **23** and the rotary plates **22** thereby rotate to rotate the clamp pins **21**, and the clamp pins **21** stop at the positions for unclamping the substrate W. In this way, all the clamp pins **21** are put out of clamping operation. After being unclamped, the substrate W on the slanted surfaces of the clamp pins **21** is conveyed by the aforementioned conveyance mechanism.

In such spin treatment steps, when the clamp pins **21** are put in or out of clamping operation, the magnet gears **31***a* or **32***a* rotate while maintaining a constant attractive force between the magnetic poles because there is no changed in the distance between the magnetic poles, i.e., the distance between each magnet gear **31***a* and the rotation magnets **31***b* and the distance between each magnet gear **32***a* and the rotation magnets **32***b*. For this reason, the clamp pins **21** can rotate at a constant velocity. The even rotation of the clamp pins **21** prevents the substrate W from being offset from its predetermined position, enabling precise centering of the substrate W.

By lowering the two sets of up-and-down arms **31***c* and **32***c* separately (on a set-by-set basis), the alternately-located three clamp pins **21** are synchronized to be able to clamp the substrate W with the substrate W being centered. The six clamp pins **21** form two sets of three clamp pins **21**, each set functioning as a three-claw clamp. Conversely, by elevating one of the two sets of up-and-down arms **31***c* and **32***c*, the alternately-located three clamp pins **21** corresponding to that set can be put out of clamping operation. Hence, even when the substrate W is rotating, half of the clamp pins **21** can change from the clamping state to the unclamping state and from the unclamping state to the clamping state alternately. During rotation of the substrate W, the substrate W must be clamped with a constant clamping force. Hence, when the substrate W is clamped with one of the groups of clamp pins **21** and unclamped with the other group of clamp pins **21**, the treatment liquid can be spread over to the contact portions between the substrate W and the clamp pins **21** to prevent the substrate W from remaining untreated partially.

The mechanism for putting the clamp pins **21** into and out of operation is achieved independent of the mechanism for rotating the substrate W, and moreover, a mechanism for transforming linear motion into rotation can be achieved in a contactless manner. To be more specific, a simple mechanism is achieved, which is capable of putting the clamp pins **21** into and out of operation from the non-rotating side even during rotation of the substrate W, and of implementing the function of moving the clamp pins **21** away from the substrate reliably when unclamping the substrate W and the function of aligning the center of the substrate W with the center of rotation when clamping the substrate W.

As described above, according to the first embodiment, the clamp pins **21** are rotated by using the magnet gears **31***a* (or **32***a*) and the rotation magnets **31***b* (or **32***b*), i.e., by magnet-type pin rotation. Thus, generation of dust can be suppressed. Further, during the pin rotation, the distance between the magnetic poles, i.e., the distance between each magnet gear **31***a* (or **32***a*) and the rotation magnets **31***b* (or **32***b*) is maintained to be constant. Thus, the clamp pins **21** can be rotated evenly, preventing the substrate W from being offset from its predetermined position when clamped.

Second Embodiment

With reference to FIGS. **9** and **10**, a second embodiment is described.

The second embodiment is basically the same as the first embodiment. Hence, only the difference between the first embodiment and the second embodiment (the structure of the rotation magnets **31***b* and **32***b*) is described. Portions in the second embodiment that are the same as those in the first embodiment are denoted by the same reference numerals as those used in the first embodiment, and are not described again here.

As shown in FIG. **9**, a spin treatment apparatus **1** according to the second embodiment has a rotation magnet **31***b* provided to a tip end portion of each of the up-and-down arms **31***c*, and a rotation magnet **32***b* to a tip end portion of each of the up-and-down arms **32***c*. The rotation magnet **31***b* and the rotation magnet **32***b* have the same structure; therefore, the rotation magnet **32***b* is not described. The up-and-down arms **31***c* and **32***c* do not have the through-holes **33** provided in the first embodiment.

As shown in FIG. **10**, the rotation magnet **31***b* is a planar magnet having north magnetic-pole parts (e.g., bands) and south magnetic-pole parts (e.g., bands) arranged alternately vertically. This planar magnet has a plate-shaped structure in which multiple (e.g., four) magnetic-pole parts are arranged on a plane parallel to the spiral magnetic-pole parts (slanted magnetic-pole parts) of the magnet gear **31***a*, in a slanted manner to match the slanted magnetic-pole parts of the magnet gear **31***a*.

When the planar magnet moves up in a direction of arrow A1 shown in FIG. **10**, the magnet gear **31***a* rotates in a direction of arrow A2 shown in FIG. **10**. Since the planar magnet and the magnetic-pole parts of the magnet gear **31***a* attract each other, the planar magnet moves up while maintaining the state of attracting and being attracted by the magnetic-pole parts of the magnet gear **31***a*. The spiral arrangement of the magnetic-pole parts of the magnet gear **31***a* causes the magnet gear **31***a* to rotate in the direction of arrow A2 to maintain the attracting state as the planar magnet moves up in the direction of arrow A1. The rotation of the magnet gear **31***a* caused by the elevation of the planar magnet is performed with a constant attractive force being maintained because there is no change in the distance between the magnetic poles, i.e., the distance between the planar magnet and each magnet gear **31***a*. When the planar magnet moves down in a direction opposite to the one indicated by arrow A1, the magnet gear **31***a* rotates in a direction opposite to the one indicated by arrow A2.

As described above, the second embodiment can offer similar advantageous effects to those offered by the first embodiment. Specifically, the clamp pins **21** are rotated by using the magnet gears **31***a* (or **32***a*) and the rotation magnets **31***b* (or **32***b*) which are the planar magnets, i.e., by magnet-type pin rotation. Thus, generation of dust can be suppressed. Further, during the pin rotation, the distance between the magnetic poles, i.e., the distance between each magnet gear **31***a* (or **32***a*) and the rotation magnet **31***b* (or **32***b*) is maintained to be constant. Thus, the clamp pins **21** can be rotated evenly, preventing the substrate W from being offset from its predetermined position when clamped.

In the first and second embodiments, power of clamping the substrate W is determined by the magnetic force or the spring force (power with which the clamp springs **35** push down the up-and-down arms **31***c*, **32***c*), and the position of clamping the substrate W is determined by the height at which the up-and-down arms **31***c* or **32***c* stop. For these reasons, it is possible to check whether the substrate W is being clamped properly or not by detecting the position of the height of the up-and-down arms **31***c* or **32***c*. By permitting half of the clamp pins **21** to be put out of operation only if it has been checked that the substrate W is being clamped properly, troubles can be prevented, such as displacement of the substrate W caused when the substrate W is being clamped with insufficient power when the clamp pins **21** are put out of operation. Accordingly, troubles caused by performing a treatment with the substrate W being clamped with insufficient power can be prevented by having a sensor configured to detect the height of the up-and-down arms **31***c* or **32***c* or the up-and-down ring **31***d* or **32***d* and a judgment unit (the controller **7**) configured to judge, based on the height detected by the sensor, whether the substrate W is being properly clamped with the clamp pins **21**.

In addition, although a disc-shaped substrate such as a circular wafer is used as the substrate W to be subjected to treatments in the first or second embodiment, the shape of the substrate W is not limited. For example, the substrate W to be subjected to treatments may be a rectangular glass substrate, such as a liquid crystal panel. This case also requires at least three clamp pins **21**. It is however preferable to have four clamp pins **21** to improve the stability of clamping the substrate W. Furthermore, in a case where two sets of four clamp pins **21** are provided, the substrate W can be clamped by those sets alternately during treatment, as in the case described above.

Third Embodiment

With reference to FIG. **11**, a third embodiment is described.

The third embodiment is basically the same as the first embodiment. Hence, only the difference between the first embodiment and the third embodiment (an arm movement mechanism) is described. Portions in the third embodiment that are the same as those in the first embodiment are denoted by the same reference numerals as those used in the first embodiment, and are not described again here.

As shown in FIG. **11**, in a spin treatment apparatus **1** according to the third embodiment, the up-and-down arms **31***c* or **32***c* for one or two clamp pins (chuck pins) **21** are each configured as a movement up-and-down arm **101** which can move up and down independently of and in parallel with the other up-and-down arms. The movement up-and-down arm **101** is pushed by a spring **103** so as to be able to move independently of and in parallel with the other up-and-down arms along a slide shaft **102** fixed to the up-and-down ring **32***d*. A rotary stopper shaft **104** is fixed to the magnet gear **32***a* and rotates together with the magnet gear **32***a*. A stationary stopper shaft **105** is also provided so that the substrate W clamped by the clamp pins **21** can be positioned near the center position. The rotary stopper shaft **104** and the stationary stopper shaft **105** function as a mechanism for positioning and stopping the movement up-and-down arm **101**.

By the addition of such a configuration, the magnet gear **32***a* can rotate and move the clamp pin **21** until the rotary stopper shaft **104** hits the stationary stopper shaft **105**. Once the rotary stopper shaft **104** hits the stationary stopper shaft **105**, the magnet gear **32***a* stops rotating so that the movement up-and-down arm **101** stops moving down. Meanwhile, the other up-and-down arms keep moving down to rotate the magnet gears **32***a*. Thus, the substrate W is pushed by the other clamp pins **21** at the position determined by the stopped clamp pin **21**. Addition of this mechanism allows the substrate W to be placed at a predetermined position. Note that such a mechanism can be installed for one clamp pin **21** or two clamp pins **21** not opposed to each other with the substrate W in between.

As described above, the third embodiment can offer similar advantageous effects to those offered by the first embodiment. Moreover, the addition of the mechanism according to the third embodiment enables the substrate W to be positioned more precisely, so that the substrate W can be reliably prevented from being displaced when clamped.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

What is claimed is:

1. A spin treatment apparatus that performs a treatment while rotating a substrate, the spin treatment apparatus comprising:

at least three clamp pins configured to come into contact with an outer peripheral surface of the substrate and clamp the substrate;

a plurality of rotatable pin rotators provided for respective clamp pins and each configured to retain a corresponding clamp pin at a position offset from a rotation axis of the pin rotator which is parallel with a rotation axis of the substrate;

a plurality of magnet gears provided for respective pin rotators around outer peripheral surfaces thereof and each having a magnetic-pole part formed spirally along the rotation axis of the pin rotator;

a plurality of rotation magnets provided for respective magnet gears and positioned so as to attract and be attracted by the magnetic-pole part of a corresponding magnet gear; and

a movement mechanism configured to move the plurality of rotation magnets in a direction of the rotation axes of the pin rotators.

2. The spin treatment apparatus according to claim **1**, wherein

the movement mechanism includes

a retainer configured to retain the plurality of rotation magnets and to move in the direction of the rotation axes of the pin rotators, and

an up-and-down mechanism configured to move the retainer in the direction of the rotation axes of the pin rotators.

3. The spin treatment apparatus according to claim **2**, wherein

the movement mechanism positions and stops the retainer.

4. The spin treatment apparatus according to claim **3**, wherein

six clamp pins are provided as the clamp pins, and alternate three of the six clamp pins in a peripheral direction of the substrate form one set,

the plurality of rotation magnets are provided in groups for the respective sets of the clamp pins, and

the movement mechanism moves the plurality of rotation magnets for the sets of the clamp pins on a set-by-set basis in the direction of the rotation axes of the pin rotators.

5. The spin treatment apparatus according to claim **4**, wherein

during treatment of the substrate, the movement mechanism moves the plurality of rotation magnets for the sets of clamp pins alternately on the set-by-set basis in the direction of the rotation axes of the pin rotators.

6. The spin treatment apparatus according to claim **2**, wherein

six clamp pins are provided as the clamp pins, and alternate three of the six clamp pins in a peripheral direction of the substrate form one set,

the plurality of rotation magnets are provided in groups for the respective sets of the clamp pins, and

the movement mechanism moves the plurality of rotation magnets for the sets of the clamp pins on a set-by-set basis in the direction of the rotation axes of the pin rotators.

7. The spin treatment apparatus according to claim **6**, wherein

during treatment of the substrate, the movement mechanism moves the plurality of rotation magnets for the sets of clamp pins alternately on the set-by-set basis in the direction of the rotation axes of the pin rotators.

8. The spin treatment apparatus according to claim **1**, wherein

six clamp pins are provided as the clamp pins, and alternate three of the six clamp pins in a peripheral direction of the substrate form one set,

the plurality of rotation magnets are provided in groups for the respective sets of the clamp pins, and

the movement mechanism moves the plurality of rotation magnets for the sets of the clamp pins on a set-by-set basis in the direction of the rotation axes of the pin rotators.

9. The spin treatment apparatus according to claim **8**, wherein

during treatment of the substrate, the movement mechanism moves the plurality of rotation magnets for the sets of clamp pins alternately on the set-by-set basis in the direction of the rotation axes of the pin rotators.

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